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AGRICULTURAL
Research

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Regional Research

World-renowned achievements at large research centers provide ample evidence of the wisdom of the trend away from small field stations.

The present emphasis is toward larger centers, where the combined efforts of scientists in many disciplines lend breadth and depth both to the research attack and to the scientist's own development.

ARS has eliminated 41 of its small stations since 1958. Four-fifths of all ARS scientists now work in cities or metropolitan areas that have a large university, and another tenth are stationed at locations where there are 15 or more scientists.

Today's top-flight scientists require substantial backstopping. To obtain results in increasingly complex studies, they must have a scientific environment that contains the tools and facilities most conducive to progress. A scientist's work may require electron microscopes, electronic computers, equipment to handle atomic energy materials, or industrial pilot plants. His work demands, too, the subprofessional and administrative assistance that is often inadequate in small laboratories.

Such backstopping can often be provided at a comparatively low cost by locating a laboratory near an existing center of research. This was the case in 1958 when ARS established its Pioneering Research Laboratory in Animal Genetics at Lafayette, Ind. It is operated in cooperation with Purdue University's Population Genetics Institute and the Purdue Agricultural Experiment Station.

In the past 7 years, ARS has located 27 of 32 large building projects on or near land grant colleges or universities—or near State agricultural experiment stations. ARS has, in addition, about 2,300 employees working on college campuses and at State-owned field stations and spends approximately $20 million each year at these locations.

Editor: R. E. Enlow
Contributors to this issue:
V. R. Bourdette, W. E. Carnahan, M. K. Dickson, A. J. Feeney, E. J. Fitzgerald, D. W. Goodman, W. W. Martin, J. R. Parker, H. H. Smith.

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Orville L. Freeman, Secretary,
U.S. Department of Agriculture

B. T. Shaw, Administrator,
Agricultural Research Service

Now Known . . .

Chloride Needs of Chicks

■ The chloride requirements for optimum growth in chicks have been determined in cooperative investigations by animal nutritionists of ARS and the Cornell University Agricultural Experiment Station.

The amount of chloride needed is extremely small—as little as 1.4 grams per 1,000 grams of ration. And R. M. Leach, Jr., of ARS and M. C. Nesheim of Cornell say this requirement can be met by feeding sodium chloride. The amount of this compound required to provide sufficient sodium for young chicks will also furnish enough chloride.

Trace elements, how they function

The research on chloride is one phase of efforts by scientists at the U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, N.Y., to learn the way trace elements function in animals and how the requirements for these elements are affected by other components in the diet. Mineral elements needed in very small amounts are called trace elements.

To determine the symptoms of chloride deficiency, the nutritionists fed chicks a purified diet containing 0.195 gram of chloride per 1,000 grams of ration.

These studies showed an extremely poor growth rate, a high mortality, dehydration, a reduced level of chloride in the blood, and a characteristic nervous disorder.

When chloride-deficient chicks were stimulated by a sharp noise or handling, they pitched forward and extended their legs to the rear as in a state of tetany. Spontaneous recovery occurred after 1 or 2 minutes, and another nervous spasm could not be induced for several minutes after recovery.

The nervous symptoms of chloride deficiency were absent when chicks were fed more chloride—0.7 gram per 1,000 grams of ration. For maximum growth, however, twice that amount of chloride was required.

Other levels influence deficiency

Leach and Nesheim learned that chloride deficiency is influenced by the levels of sodium, potassium, bromide, and iodide in the ration.

Changing the sodium and potassium contents of the diet had no effect on the growth rate of chloride-deficient chicks. But reducing the amounts of these elements produced significant increases in the blood chloride level. And high sodium and potassium levels increased the occurrence of the nervous disorder typical of pronounced chloride deficiency in chicks.

Replacing an insufficiency of chloride with a small amount of bromide

(equal to 0.3 gram of chloride per 1,000 grams of ration) did not affect the characteristic nervous disorder, but it partially counteracted other symptoms of chloride deficiency. Higher bromide levels were of no additional value.

High levels of iodide intensified the nervous symptoms of chloride deficiency and increased mortality in chloride-deficient chicks. Adding chloride to the diet reversed these effects, but it did not nullify the depressed growth rate associated with high iodide levels.☆

Distinctive nervous spasm, a sign of severe chloride deficiency, holds the chick rigid for 1 or 2 minutes—then releases it.

A Reverse Attractant

Substance that attracts female boll weevil has been extracted from male weevils

■ The boll weevil has become the 12th insect species from which ARS entomologists have obtained a sex attractant. But the boll weevil attractant is a "first" in one respect—it is the first obtained from males.

Entomologists at the Boll Weevil Research Laboratory, State College, Miss., investigated the possibility of extracting a female attractant from the male after observing female weevils in cooperative research at the Mississippi Agricultural Experiment Station.

Behavior of boll weevils in the laboratory clearly demonstrated that females seek out the males for mating. A detailed field study in 1963 augmented these findings. Females went as far as 30 feet to plants containing males; no males were seen going to females.

To obtain the natural attractant, the scientists drew air through a plastic cage—containing male weevils—into a column of activated charcoal. After 11 weeks, they removed the charcoal and soaked it in chloroform. When the chloroform evaporated, it left a residue that attracted female boll weevils in trapping tests.

Without exception, more female weevils were caught in traps containing the residue than in untreated traps. In 12 tests, catches in treated traps averaged 155.8 female weevils, compared with an average of 3.5 females for untreated traps.

Chemists are attempting to chemically identify the attractant, the next step toward synthesizing the substance for possible use in boll weevil control.☆

Rating Phosphate Rock

Way to classify fertilizer potential of new deposits has implications for world phosphate needs

■ The rapid increase in world use of phosphate fertilizers—now averaging 8 percent per year—has accentuated the need for a method of rating new phosphate rock deposits according to their value as fertilizer.

To answer this need, ARS chemists W. M. Hoffman and H. J. Breen at the U.S. Fertilizer Laboratory, Beltsville, Md., have devised a handy classification scale, based on the solubility of phosphate rock in a 2-percent citric acid solution.

The 2-percent citric acid solubility test, developed under Hoffman's direction, is less expensive and time consuming than methods previously used in analytical laboratories (AGR. RES., Sept. 1961, p. 15).

Earlier research by ARS chemists J. H. Caro and W. L. Hill showed that citrate solubility is an accurate indication of the availability of phosphorus to plants and consequently can be used to evaluate phosphate rock as a fertilizer source. The degree of solubility of a phosphate mineral, determined from single extractions with 2-percent citric acid or neutral ammonium citrate, proved directly related to yields of crops grown in greenhouse cultures supplemented by the phosphate fertilizer.

In developing the classification scale, Hoffman and Breen rated 14 mineral phosphates — representing well-known phosphate rock sources— by three tests: 2-percent citric acid solubility, a modification of a method formerly recommended by the Association of Official Agricultural Chemists; neutral ammonium citrate solubility, the association's present official method; and alkaline ammonium citrate solubility, similar to the official method of The Netherlands.

Although the three tests differ in detail, they all consist of agitating a sample of phosphate rock in solution, filtering the solution to recover the extracted phosphorus, and then analyzing the filtrate for phosphorus content.

The chemists say four repeated extractions with 2-percent citric acid provided the most accurate indication of the amount of phosphorus available to plants in phosphate rock.

Based on the results of these experiments, the scientists prepared a solubility index that rates phosphate sources on a numerical scale from 0 (lowest solubility) to 10 (greatest solubility). The ratings of 10 well-known phosphate sources of varying solubility provide a comparison scale for classification of new deposits.

The chemists say, however, that further research is needed to correlate the index numbers with results of previously used methods for evaluating phosphate rock minerals.☆

Wasps Against Weevils

Strategy for alfalfa pest advances biological control in the East

■ When ARS entomologists discuss biological control of the alfalfa weevil in the Eastern United States, they often sound more like military tacticians than scientists.

Northern line . . . southern line . . . middle line . . . establish . . . advance . . . disperse . . . recovery . . . attack. These military-sounding words are mixed with typical scientific terminology.

Terminology notwithstanding, the release, recovery, and evaluation of parasites and predators of the alfalfa weevil is a job for scientists. It is part of an overall research effort, in cooperation with State research workers and alfalfa growers, to develop effective controls for this insect pest, which in only 12 years has become by far the most destructive forage-crop pest in the East. Until 1951, it occurred in the United States only in the West.

Lack of natural enemies

A lack of natural enemies was one of the conditions in the East that permitted the weevil to spread rapidly. (AGR. RES., June 1961, p. 5.) In 1959, ARS entomologists started research to change this situation.

Since the few native enemies of the weevil in the East were ineffective, the entomologists concentrated on finding natural enemies elsewhere and introducing them. The first introduction was a parastic wasp, *Bathyplectes curculionis*, which was collected in California. This parasite had been introduced into Utah from Italy about 50 years ago.

Entomologists at the Parasite Introduction Laboratory, Moorestown, N.J., found that the wasp will overwinter in the East. They released *B. curculionis* in seven alfalfa fields in Delaware, New Jersey, and Virginia—and later found parasitized weevils at all sites.

Preliminary trials are held first

The Moorestown laboratory is part of a worldwide operation in which scientists search for beneficial insects that might attack and destroy harmful insects or weeds (see pp. 8 and 9 of this issue). Preliminary field trials of potentially useful insects often are conducted at Moorestown. Then other scientists working on specific pest problems take over to test the parasites or predators in extensive field trials.

Entomologists at Beltsville, Md., coordinate the long-term field testing of parasites and predators of the alfalfa weevil in the East. They cooperate with many scientists and farmers in the States.

One of the first things the Beltsville scientists did when they started the tests was to carefully plot release lines. The lines are roughly parallel, about 350 to 400 miles apart, with release sites at 50- to 75-mile intervals

UPPER LEFT—Parasitic wasp, brought to the East from California, attacks an alfalfa weevil larva. The wasp larvae feed on and kill the host.
LOWER LEFT—Beneficial wasps are released for combat in stand of alfalfa.

along each line. One objective in this careful plotting is to test parasites and predators in the full range of ecological and climatic conditions in the East's weevil-infested area.

The carefully plotted lines and release sites are part of a long-term plan to very accurately follow the dispersal of parasites and predators, to get data on how fast these natural enemies move, and to find out what percent of the weevil population they attack.

Wasp released at 30 sites

In the ARS-State cooperative field tests, the parasitic wasp *B. curculionis* has been released at 30 sites—13 sites in 1961, 12 sites in 1962, and 5 sites in 1963. Recoveries have been highly encouraging, but evaluations will have to continue at least 2 more years before the scientists can determine whether the wasp is likely to take hold and significantly reduce weevil populations.

At best, *B. curculionis* can be only a partial answer. Entomologists don't expect this parasite—or any *single* natural enemy—to give complete control. A variety of parasites is needed to fill in all the niches, the scientists explain. *B. curculionis* attacks the larval stage of the weevil, laying eggs in the host larva. When the eggs hatch, the wasp larvae feed on the host weevil larva and kill it. Not only would the scientists like other parasites to attack the larval stage, but they also want parasites that attack the egg, pupa, and adult. The combined effect of several kinds of parasites should provide a higher level of population control than only one species.

The only other enemy of the weevil that has been released on a large scale is *Tetrastichus incertus*, a second parasitic wasp that attacks the larval stage. This wasp has been released at most of the sites where *B. curculionis* has been released, but recoveries of *T. incertus* have not yet been attempted at most of the sites. It is known, however, that this wasp will overwinter in some locations.

Entomologists say dispersal of *T. incertus* from one release site in Pennsylvania was "fantastic." This release was made near Oxford in 1961. By the end of the summer of 1962, the parasite had spread over an estimated 1,000 square miles and had made its way into Maryland and Delaware. By the end of the summer of 1963, the entomologists estimate, the wasp had spread over 3,000 square miles.

Other natural enemies studied

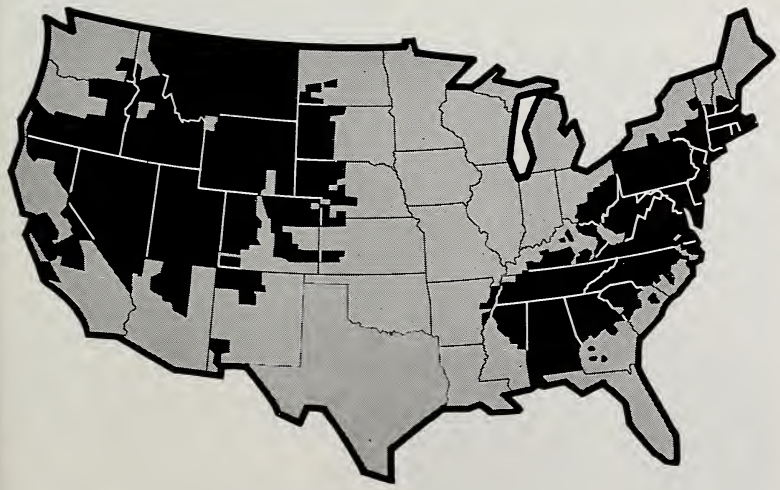
In all, six natural enemies of the alfalfa weevil have been imported and released. Five are parasites, one is a predator; all are wasps (Hymenoptera). Entomologists are also eying several other natural-enemy wasps, including one parasite that apparently is native to the East.

Two species of *Microctonus* are promising. One, *M. aethiops*, an imported species first released in this country against the sweetclover weevil in North Dakota, lays eggs in adult weevils. The other wasp, a native *Microctonus* without a species name, apparently has been in the East all along. The entomologists at Moorestown have established a colony in New Jersey and, in 1963, turned insects over to Beltsville scientists, who made a release in North Carolina.

Two *Bathyplectes* species in addition to *B. curculionis* are other possibilities. One species, *B. anura*, an import from Europe, was released in Pennsylvania and New Jersey in 1963; the other, which has no species name, is now at Moorestown undergoing preliminary investigations.

ARS entomologists also have released a pupal parasite, *Dibrachoides druso*, and an egg predator, *Peridesmia discus*. Neither species has been recovered to date, but recovery surveys are continuing.

Meanwhile, the search for new natural enemies goes on, both in this country and abroad.☆



Unless spread can be slowed down, alfalfa weevil infestation in the East will merge with the West's in a few years. Natural insect enemies in the West have lessened weevil destruction there, entomologists believe.

Combing the World for...

INSECT ALLIES

A scientist is interviewed about a complex mission

■ Exploration for beneficial insects is a highly important part of USDA's effort to find effective and economical methods of controlling pests.

Insects that attack and destroy harmful insects and weeds provide a nearly ideal form of biological control. And entomologists of USDA's Agricultural Research Service and the State agricultural experiment stations continually search for allies in the insect world.

This search takes them to the far corners of the world—where, in the pest's native environment, they look for natural enemies that through the centuries have struck a sort of "nature's balance" with their prey.

AGRICULTURAL RESEARCH recently had an opportunity to get a firsthand report on this exacting science when R. I. Sailer, head of the European Parasite Laboratory, near Paris. visited his Beltsville, Md., headquarters. Following are excerpts from an interview with him:

How long has USDA had insect explorers abroad?

A USDA entomologist went to Australia in 1888 to look for biological-control agents of citrus pests. In Europe, exploration began in 1905, in a search for natural enemies of the gypsy moth. Except for the war years, the Paris laboratory has been manned continually since 1922.

How many scientists do you have?

There are five at present—myself, two other American scientists, and two Europeans.

What special training is needed?

I'd say, insect taxonomy and ecology. You have to be able to identify the parasites, many of which are new to science. Also, you have to know the conditions that regulate abundance of insects.

How is a search initiated?

First, the fact must be established that an insect needs to be controlled. We must also know where the pest came from. Then we must find out how important the pest is in its native land. If something is keeping it under control there, our chances of finding a beneficial insect are good.

What is the next step?

Sailer, reporting on insect exploration, formerly was stationed at Beltsville as assistant chief of ARS work on insect identification and parasite introduction.

We study research reports of entomologists, especially those in the area where the pest is found, to see whether parasites or predators of the pest have been discovered. If they have, our job is somewhat simplified.

Then what?

We have to find an insect explorer—plus, of course, sufficient funds to support his work. And arrangements must be made for the explorer to work in the foreign country. Once there, he collects specimen pests to learn what is attacking them. If he finds parasites, internal or external, he tries to identify them and find out if they are specific to the pest. He also must find out whether a beneficial parasite is attacked by another parasite. If it is, he must eliminate secondary parasites before sending the beneficial parasite to our quarantine station in Moorestown, N.J.

What happens at Moorestown?

The beneficial parasites are reared, tested, and then shipped to Federal or State laboratories for release in infested areas.

That sounds simple.

But it isn't. Almost every beneficial parasite or insect we find is unfamiliar to us. We have to learn its habits and life cycle. We must find out if it can survive under our

Parasitic Lydella fly, poised on cornstalk, deposits larva in tunnel made by borer.

Tiny wasps, here magnified about six times, help suppress red scale. This parasite is from India and Pakistan.

field conditions. And, most important, we must learn whether a parasitic insect's life cycle will coincide with that of its host under our climatic conditions.

Can you cite a few successful introductions?

Yes . . . a wasp that parasitizes the alfalfa weevil; four wasps that effectively control the citrus blackfly in Mexico and thus prevent its entering the United States: a fly that parasitizes the European corn borer (see illustration above); a wasp that attacks the European stem sawfly; and a group of flies and wasps that have kept the browntail moth and satin moth from becoming serious pests of our shade trees.

How does the USDA laboratory in Rome differ from yours?

We work mostly on natural enemies of insects. In Rome, the search is for insects that attack weeds. We often cooperate. For example, we are now collecting specimens of a fly that lays eggs in the flowers of the tansy ragwort, a noxious weed. The fly larvae eat the seeds of the weed and decrease the weed's reproduction. The fly is being tested to make sure it feeds only on tansy ragwort.

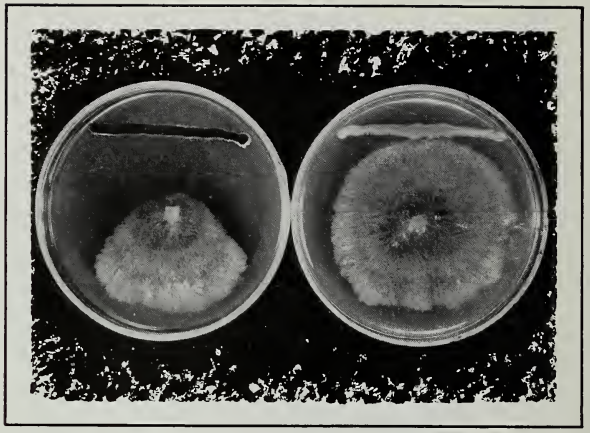
Any other cooperators?

Yes. We work closely on many projects with Commonwealth Institute of Biological Control laboratories in Europe, Asia, and Africa . . . with agriculture officials in Australia and Canada . . . with entomologists in Europe and South America . . . and with insect explorers from the agricultural experiment stations of California and Hawaii. Release of beneficial insects in the United States is conducted cooperatively with USDA's Forest Service for the control of forest insects and with States where a particular insect pest is active.

Are more scientists needed in this field?

Yes, primarily because the more we learn, the more we'll have to learn. Not long ago, for example, entomologists estimated that there are about a million different kinds of insects. For each of the pests we've studied, an average of 20 different parasites or predators has been found. Most of these beneficial insects are unfamiliar to us, and each of them, in turn, is attacked by other insects about which little or nothing is known.

As the jingle says, "Big bugs have little bugs upon their backs to bite 'em. Little bugs have littler bugs, and so ad infinitum."☆



Antibiotic produced by strain of soil bacteria, which appear as a black bar (left), inhibits growth of fuzzy disease-causing fungus. Same fungus is thriving (right) near other bacterial strain.

Rx FOR ROOT ROT?

Basic studies raise hope for biological control of fungus disease in beans

■ Use of shredded oat straw in the soil effectively suppressed soilborne fungi that cause root rot in beans, ARS microbiologists found during basic studies to develop biological control of costly and damaging soilborne diseases.

Working shredded straw into soil brings the ratio of carbon to nitrogen in the soil around plant roots into a range that encourages development of organisms antagonistic to the root rot fungi, report G. C. Papavizas and C. B. Davey. In a related study, at least one of these organisms, a bacterium, produced an antibiotic that inhibited the growth of several fungus disease pathogens.

The experimental oat-straw method is one of several potential control methods being studied. Since the work is still at an early stage, field application to control bean root rot is not yet practical.

Organisms involved in biological control of root rot fungi include *Streptomyces* organisms, true bacteria, and fungi. Four different root rot fungi were used to inoculate the soil in the Papavizas-Davey experiments. The trials were conducted in three basic soil types—strongly acid, mildly acid, and alkaline.

The scientists found that raising the carbon-nitrogen ratio in the root zone to a range between 30 to 1 and 80 to 1 increased the number of organisms antagonistic to root rot fungi.

In contrast, heavy applications of nitrogen fertilizer decreased the number of organisms effective against root rot fungi in all three soil types (with or without straw) when the soil's carbon-nitrogen ratio dropped to 10 to 1 or lower.

30 million antagonists

In strongly acid loam, for example, antagonists to Fusarium organisms averaged 30 million per gram of soil in the root zone where the carbon-nitrogen ratio was 50 to 1, compared with only 1 million antagonists per gram of soil where the ratio was 10 to 1. In alkaline loam, the counts averaged 6.6 million antagonists per gram of soil where the ratio was 50 to 1, and only 1.4 million where the ratio was 10 to 1.

There was also a difference in the type of antagonists that increased in different soils, the scientists report. In strongly acid soil, the majority that increased were true bacteria; in contrast, antagonists increasing in alkaline soil were chiefly *Streptomyces*—a difference the scientists have not yet been able to explain.

The bacterium-produced antibiotic that is active against fungus disease organisms was discovered by Papavizas and W. A. Ayers. They have identified the antibiotic as the product of a purple-colored soil bacterium probably belonging to the genus *Pseudomonas*. Located very close to plant roots, the bacterium's outstanding cultural characteristic is a tendency to develop the violet pigmentation.

In the Papavizas-Ayers tests, the new antibiotic suppressed 14 out of 18 different fungus organisms, mainly disease pathogens. The action of the antibiotic seems to be selective, however. Tested against two Fusarium wilt strains, the antibiotic strongly inhibited one—but it had virtually no effect on the other. More research is needed to better understand the antibiotic's relation to pathogenic fungi and its role in the life cycle of the bacterium that produces it.

Violet-colored bacteria of this type are peculiar to acid soils. The bacteria are not numerous in soil, but they may be distributed quite widely in the world. A Maryland soil was used in the Papavizas-Ayers research, and a similar strain of bacteria has been reported in soil studies made on the West Indies Island of Trinidad.☆

Rain Affects... Fallout Buildup in Plants

● Most of the radioactive fallout that accumulates in plants directly from the atmosphere—not from the soil—apparently occurs during rainy weather.

● Only minute amounts of fallout are translocated through the plants to roots and fruit.

These recent findings by ARS scientists add to the growing body of information about fallout on plants. In an emergency—which everyone hopes will never occur—ARS would have a principal role in safeguarding the Nation's food and livestock feed.

As a part of the national defense effort, ARS scientists are studying how fallout accumulates and moves through plants. Should fallout ever approach levels dangerous to human health, scientists would need ways of assessing the safety of growing crops.

Earlier ARS research indicated that the main source of strontium 90 in plants was atmospheric fallout which had settled on the foliage. These studies also suggested that rainfall played a major role in strontium 90 deposition. Strontium 90 is one of the radioactive materials most readily taken up by plants.

Field experiments at Belle Glade, Fla., and Brawley, Calif., confirmed the earlier findings. In these experiments, contamination from the atmosphere between rains was so small it could not be measured. Supporting this was the fact that contamination accumulating in plants between rains about equaled the estimated uptake from the soil.

ARS soil scientists R. G. Menzel, H. J. Roberts, Jr., and E. H. Stewart and ARS chemist A. J. MacKenzie compared the strontium 90 contents of sweet corn, cabbage, potato, and bean plants sampled during 6 weeks of active growth.

The scientists collected foliage samples before and after three rains at Belle Glade. No rain fell during the experiment at Brawley, and samples were taken there at equally spaced intervals. Laboratory analyses of plant samples were made at the U.S. Soils Laboratory, Beltsville, Md.

Researchers found that the strontium 90 content increased greatly during each rainy period at Belle Glade, except when plants were very small. The amount of radiostrontium accumulated was apparently related to the amount of foliage. The most strontium 90 was taken up during the third rainy period, when plants were largest and rainfall was less intense.

The greatest amount of strontium found during the studies (calculated at about 1.6 microcuries per acre in 10-week-old sweet corn) was far below levels established as dangerous to human health by the Federal Radiation Council.

The scientists estimated the 6-week uptake of strontium 90 from the soil at about 0.06 microcurie per acre at Brawley and 0.15 microcurie at Belle Glade. A substantial part of the strontium content of crops at Brawley (where no rain occurred) probably came from the soil.

In a separate Beltsville study, ARS plant physiologist J. E. Ambler determined the amount of radiostrontium translocated from leaves to other plant parts.

Working at the U.S. Soils Laboratory, Ambler applied a solution containing strontium 85 to single leaves of laboratory-grown bean and corn plants during their vegetative and early-fruit stages of growth. (Strontium 85 is used in the laboratory because it is easier to handle than strontium 90.) Some leaves were wetted daily until harvest and others were kept dry. Ambler determined the amount of translocation by analyzing plant parts for strontium 85 with a gamma ray spectrometer. Here is what he found:

● Radiostrontium movement from unwetted leaves to other parts of plants was practically zero.

● Translocation from wetted leaves to fruits and roots was less than 0.006 percent of the strontium 85 applied.

● Maximum movement from wetted leaves to other leaves and stems was 0.5 to 0.6 percent of the amount applied.

● Young leaves translocated more radiostrontium than older leaves, and the most translocation occurred from treatments made during early fruit development.

● Although certain edible parts of plants may be contaminated by direct exposure to fallout, relatively little radiostrontium would move to other parts of the plants.☆

Many fingers make light work

BLUEBERRY PICKING

Mechanical harvester could cut costs, save tons of berries

■ Some agricultural leaders predict that fruit crops not harvested mechanically will someday be of minor importance, grown only as specialty items.

ARS and State agricultural engineers are working to prevent this from happening with blueberries. In cooperative research at Michigan State University, East Lansing, ARS engineers G. E. Monroe and J. H. Levin have developed an experimental machine that will harvest cultivated blueberries at less than 1 cent a pound for labor.

Unit straddles blueberry bushes

Three men and a harvester that incorporates the principles of the experimental unit should be able to do the work of 120 men harvesting by hand. One man would drive the machine while two handle berries.

The experimental unit consists of two rotating spindles, mounted vertically on a steel frame, that straddle a row of blueberry bushes. Each spindle has 160 vibrating "fingers."

As the unit moves down a row, the spindles rotate like giant turnstiles, moving the vibrating fingers in and out of the bushes. Mature blueberries are shaken off the plants and caught in wooden boxes carried at the base of the machine.

Blueberries ripen over a 4- to 6-week period, and three harvests are usually necessary to get most of the fruit. Because of the extended harvest season, hand pickers usually make only one or two harvests, then move on to other crops. As a result, tons of fruit often go unharvested. The new harvester should eliminate this problem and thus enable growers to market a far larger crop of cultivated blueberries.

Experienced hand pickers, who earn about 8 cents a pound, harvest less than half an acre of blueberries in 8 hours. In contrast, the machine can harvest more than half an acre in only 1 hour.

Hand-held vibrator came first

The development of the experimental machine is another step toward mechanization of fruit harvesting. In 1958, Levin and two other ARS engineers at Michigan, S. L. Hedden and H. P. Gaston, developed a hand-held, electrically operated vibrator and catching frame that cut the cost of harvesting blueberries to 3.5 cents a pound.

Last summer, the hand-held equipment was used to harvest about 35 percent of Michigan's blueberry crop and 20 percent of the New Jersey crop. These two States produce about 70 percent of all U.S. cultivated blueberries.☆

Lost Calories...

Survey program pinpoints food discards

■ Information on the kind, amount, and caloric value of foods discarded by U.S. homemakers has been obtained in pilot studies by ARS in two urban communities, one in California and the other in Minnesota, and in a rural county in Missouri.

Findings from these and subsequent surveys will make possible more accurate measurements of food eaten in households. The surveys reported were made in cooperation with the University of California, the University of Minnesota, and the University of Missouri.

Directed by ARS nutrition analyst Sadye F. Adelson, the studies indicate that 7 to 10 percent of the calories in household food supplies were thrown away, fed to animals, or used for nonfood purposes. This amounts to some 200 calories per person per day.

The greatest caloric loss among urban households was from discards of edible parts of meats, poultry, and fish. Among rural households, however, the greatest loss was from discards of milk products other than butter. Grain products and food fats and oils were next important in caloric loss in the three communities.

The researchers regard the results of these studies as the most accurate they have yet obtained. Even so, they believe the amount discarded by the average U.S. family may be somewhat greater than in the households studied so far.

In working to improve interview techniques, the scientists have developed a relatively simple, quick interview method that could be used to survey a greater number of families. This improved method was recently used in surveying a random sample of households in Minneapolis-St. Paul. The data collected are now being tabulated and evaluated.☆

Breaking Egg Diapause...

Corn rootworm can now be reared for research on control

■ ARS entomologists at Brookings, S. Dak., have reported an important development in studies on the western corn rootworm: they now know how to rear this species in the laboratory.

This rootworm has become a pest of growing economic importance in recent years, because it has developed resistance to recommended insecticides in many corn-growing areas.

Laboratory rearing assures a continual supply of insects for the intensive type of research that is required to study resistance—and to develop new control methods for this pest. At best, such research is difficult, and scientists are seriously handicapped if they have only a seasonal supply of insects from the natural population.

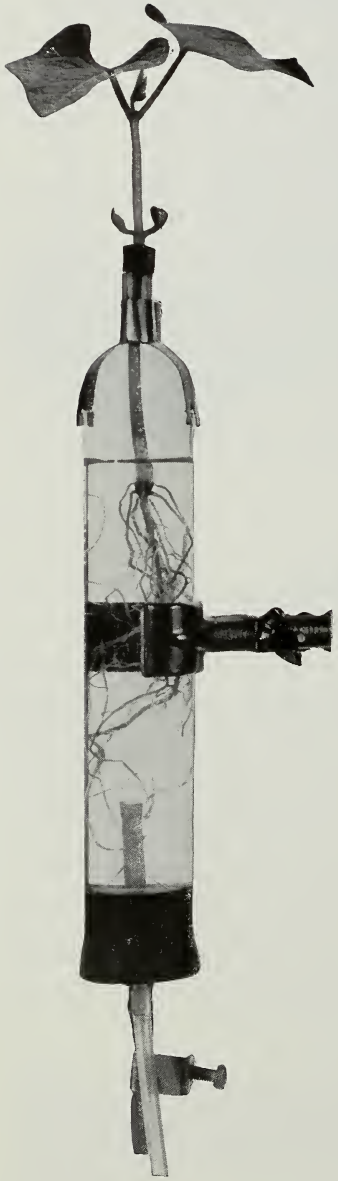
Inability to break egg diapause (stoppage of embryo growth) is the specific problem that has prevented laboratory rearing of the western corn rootworm. As long as eggs remain in diapause, they will not hatch. The key requirements for breaking egg diapause, the entomologists have found, can be met by holding the eggs in high-moisture atmosphere at 35.6° F. for 41 days.

The diapause research was conducted at the Northern Grain Insects Research Laboratory, a facility operated by ARS in cooperation with States in the North Central region.

Insecticide resistance in western corn rootworms has been a problem since 1960, when the larvae in limited areas of Nebraska became resistant to recommended insecticides that had been controlling them. Resistant western corn rootworms have occurred in larger areas every year since 1960, and in 1963 they caused severe damage in six States—Kansas, Nebraska, Missouri, Iowa, Minnesota, and South Dakota.☆

Root Exudates

Traveling growth regulators



Root exudate is applied in lanolin paste to young bean leaves and collected in precise amounts when it exudes from the roots. Tube (bottom) is used to aerate nutrient solution.

■ Chemical plant-growth regulators—even closely related compounds—differ in their ability to move within a plant, ARS plant physiologists say.

By comparing the behavior of a group of regulators that are exuded from plant roots into the surrounding soil with the behavior of a group that aren't exuded, P.J. Linder and J. W. Mitchell have learned that the exuding types move down into plant roots—but that the nonexuding types do not. All the compounds tested were applied in a lanolin paste to the leaves of young bean plants.

Scientists have been particularly interested in exuding regulators since learning that a growth modifier can move from a plant's roots into the roots of adjacent untreated plants and modify the growth of those plants (AGR. RES., January 1954, p. 3).

The basic research on root exudates is part of an effort to find more effective and economical ways to control weeds. Early work with growth regulators, for instance, led to development of the weedkiller 2,4-D (chlorinated phenoxy-acetic acid). Controlling weeds with such organic chemicals, which interfere with the metabolism of unwanted plants, is now an accepted agricultural practice.

In the experiments with exuding and nonexuding growth regulators, the scientists tested three pairs of related chemicals: 2,3,6-trichlorobenzoic acid, an exuding regulator, and 2,5-dichlorobenzoic acid, a related but nonexuding compound; alpha-methoxyphenylacetic acid (exuding), and 3,4-dichloro-alpha-methoxyphenylacetic acid (related but nonexuding); and 2-methoxy-3,6-dichlorobenzoic acid (exuding), and naphthaleneacetic acid (related but nonexuding).

Four days after 100 micrograms of the first exuding regulator, 2,3,6-trichlorobenzoic acid, were applied to the leaves of each test plant, about 1 microgram was recovered from the stem, a little less than 1 microgram from the roots. Roots of each plant exuded more than 1.5 micrograms daily for 2 days after application.

In contrast, the related nonexuding regulator, 2,5-dichlorobenzoic acid, was recovered from the stem—but not from roots. Nor was it exuded from roots in detectable amounts.

The same pattern occurred in experiments with the other two pairs of related compounds. Nearly 10 micrograms of the second exuding regulator, alpha-methoxyphenylacetic acid, were exuded from the roots of each test plant during the first 24 hours after treatment, and 2 to 3 micrograms were recovered from the roots. The related nonexuding regulator, 3,4-dichloro - alpha - methoxyphenylacetic acid, was neither recovered from plant roots nor exuded.

Following application of 100 micrograms of the third exuding regulator, 2-methoxy-3,6-dichlorobenzoic acid, a little less than 1 microgram was exuded from each plant during the first 24 hours. The compound was also recovered from the roots. The related nonexuding regulator, naphthaleneacetic acid, was neither exuded nor recovered from the roots.

Linder and Mitchell think that the reason the three nonexuding compounds were not recovered from the roots or exuded may be (1) a lack of ability to move within the plant, (2) a breaking down of the compounds chemically within the plant, or (3) binding of the compounds to certain constituents within the plant, which prevents the chemicals from reaching the roots.☆

A test for celery flavor

ARS utilization scientists have developed a simple, accurate chemical test for the intensity of celery flavor that is expected to have widespread use in the food-processing industry.

Developed by chemists H. J. Gold and Charles Wilson III at the U.S. Fruit and Vegetable Products Laboratory, Winter Haven, Fla., the test is an outgrowth of recent research which showed that celery juice has at least 58 different constituents, 6 of which are important to flavor.

To determine the intensity of the flavor in a sample of celery juice, the flavoring compounds are adsorbed on charcoal. The compounds are then washed from the charcoal with a special solution and reacted chemically to yield colored compounds. Color intensity, determined by a colorimeter, accurately tells the strength of the flavor.

Celery is used in processed foods for its unique and appetizing taste. Flavor varies with varietal differences and growing locations, however, and judging celery flavor in taste panels is both time consuming and difficult.

Powdered pumpkin is coming

Pumpkin powder—made from pure pumpkin puree—is the latest entry on the growing list of ARS-developed convenience foods.

When commercially produced, the powder would find outlets in bakeries, restaurants, and the institutional food market, and in pie mixes for home use.

Taste panels judged pies made with pumpkin powder equal in both flavor and texture to those made with fresh or canned pumpkin. And the powder offers advantages in packaging, storage, and shipping. One can contains more pumpkin solids than four cans of the commonly used puree.

The powdering process, developed by chemical engineers at the Eastern utilization research laboratory in Philadelphia, involves drying pure pumpkin puree on the same type of single-drum dryer used in making potato flakes. The dehydrated pumpkin comes off the dryer as a sheet and is then ground into powder.

With boiling water added, pumpkin powder is ready to be mixed with eggs, seasonings, and other ingredients to make pumpkin pie. Blending the powder with other dry ingredients would convert it into a pie mix that needs only eggs and water added at baking time.

Nitrogen raises seed yield

Nitrogen fertilizer may hold the key to profitable Russian wildrye seed production. This northern Great Plains grass yields palatable pasturage that is rich in protein, but it is a notoriously erratic seed producer.

ARS agronomists G. A. Rogler and R. J. Lorenz found that applications of ammonium nitrate containing 50 to 200 pounds of nitrogen per acre per year significantly increased seed production in *mature* stands of irrigated wildrye.

The research was conducted at the Northern Great Plains Field Station, Mandan, N. Dak.

In addition, Rogler and Lorenz showed that forage aftermath (plant remains following seed harvest) was also increased by nitrogen.

Wildrye is particularly valuable for forage aftermath, both because of its high protein content and because the forage is formed predominantly of basal leaves, which are not affected by seed harvest.

The increase in yields of seed began the fourth year of the fertilizer experiments, conducted for 7 years.

During the first 3 crop years, no significant differences in seed yield showed up in plots receiving seven different treatments, including plots with no fertilizer added. This was

Irrigated Russian wildrye plots in sixth year show how nitrogen builds heavy heads and lush growth. LEFT—Per-acre yield of unfertilized plot was 130 pounds seed, 1.67 tons forage. RIGHT—Plot that had received 200 pounds of nitrogen annually per acre produced 462 pounds seed and 2.97 tons forage.

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accounted for by the natural ability of the soil to supply enough nitrogen temporarily.

However, plots fertilized with nitrogen averaged 322 pounds of seed in the fourth year and 465 pounds in the fifth year, compared with 204 pounds and 72 pounds for the unfertilized plots. By the sixth year, the plots that got the heaviest nitrogen applications (200 pounds per acre) averaged 276 pounds seed. Other averages ranged from 66 to 209 pounds.

Rogler and Lorenz also learned that superphosphate fertilizer has no appreciable effect on the seed yield.

Double breeding may not pay

It usually doesn't pay to artificially inseminate beef cattle twice during the same heat period.

Many ranchers have adopted this practice to improve conception rate. But research by ARS and University of Nebraska scientists at the Fort Robinson Beef Cattle Research Station shows only a 6-percent advantage from breeding twice. This, the scientists feel, is not enough to offset the extra cost for labor and semen.

In the Fort Robinson experiment, 150 Angus and Hereford heifers were bred once, 12 hours after heat was detected. Another 150 were bred twice, once at the time heat was detected and again 12 hours later.

Of the heifers bred once, 63 percent settled, compared with 69 percent of the heifers bred twice.

Each group included about equal numbers of both breeds. The study showed no significant difference in conception rate between the two breeds in either group.

Pump halves pen-cleaning time

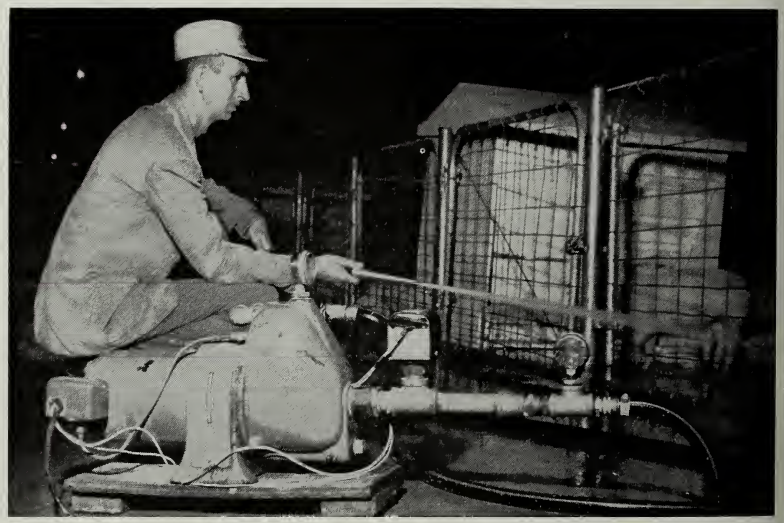
An ARS agricultural engineer's idea has made it possible for herdsmen at the University of Maryland's swine research unit to cut hog-pen cleaning time in half.

This idea, which has already been adopted by several livestock producers, was to boost the water pressure from less than 25 pounds per square inch to more than 60. To do this, engineer E. E. Jones, Jr., stationed at the College Park campus, uses a commercially available jet-type pump.

The increased water pressure makes it possible to clean the research unit's hog pens in 45 minutes instead of the usual 90 minutes or more. With the pump, the herdsmen use one-third less water, yet they can do a more thorough cleaning job. The pump also eliminates having to loosen the manure with a scraper. E. P. Young, head of Maryland's hog research, says that pen cleaning used to wear out a scraper every week.

A flow switch, which Jones installed, automatically starts and stops the pump as the water is turned on and off. The switch prevents damage to the pump, which can occur if a worker stops the water without shutting off the pump.

Jones demonstrates pressure-boosting pump that saves labor, time, and water.



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